

Current Role of Open Reconstruction of the Scapholunate Ligament

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J Wrist Surg 2013;2:116–125.

Abstract

Keywords

- ▶ SL ligament tear
- ▶ SL ligament reconstruction
- ▶ capsulodesis
- ▶ wrist ligament injury

This paper is a review of the various surgical techniques used in repair or reconstruction of the scapholunate ligament according to the clinical stages and anatomic-pathologic findings. Arthroscopy permits a direct evaluation of the scapholunate injury and the status of the articular surfaces. Specific indications for each type of scapholunate ligament tear are proposed, from the different types of dorsal capsulodesis to bone–ligament–bone techniques and tenodesis procedures. The authors' preferred techniques and literature review of the expected outcomes are presented.

The recognition and subsequent treatment of scapholunate (SL) ligament tears is not always simple to determine, and there are divergent opinions regarding its global treatment.

In recent years, the advent of arthroscopy has permitted an increase in knowledge regarding the most appropriate form of SL ligament repair.

Clinically we can define four types of instability: (1) predynamic instability; (2) dynamic instability; (3) reducible static instability; (4) nonreducible static instability. Each one of these lesions requires a specific treatment.

Predynamic Scapholunate Dissociation

“Predynamic instability” is an older term coined by Kirk Watson to apply to instability demonstrable on physical examination but not by radiographic studies.¹ This corresponds to a Geissler grade I or II instability^{2,3} or a European Wrist Arthroscopy Society (EWAS) grade 2, 3A, or 3B⁴ (▶ **Table 1**). There may be attenuation or a tear of the palmar SL ligament.

In chronic predynamic instability, three different approaches have been proposed: (1) flexor carpi radialis muscle (FCR) proprioceptive reeducation; (2) arthroscopic debridement of the torn ligament; (3) ligament shrinkage.

It is my preference to perform a dorsal capsulodesis, which provides sagittal plane stability and restricts the abnormal scaphoid flexion.

Surgical Technique

An acute partial SL ligament tear, without carpal malalignment, that can be reduced anatomically can be treated by percutaneous SL joint pinning under fluoroscopic control.^{5–7} The reduction of the carpal bones can be facilitated by placing two percutaneous Kirschner wires (K-wires) in the scaphoid and lunate and using them as “joysticks.” If there is no interposition of tissue, the SL joint can be reduced by levering the scaphoid into extension, supination, and ulnar deviation while levering the lunate into flexion and radial deviation. Two 1.2-mm K-wires are inserted through a small incision made distal to the radial styloid, taking care not to damage the radial sensory nerve branches (▶ **Fig. 1**). Some authors pin the scaphocapitate (SC) articulation as well.⁷ The wrist is immobilized with short arm cast. The K-wires are removed at 8–10 weeks, followed by a removable splint for another 4 weeks before initiating mobilization. Rehabilitation of the hands and fingers is initiated immediately postsurgery, but grip strengthening and wrist mobilization are permitted only after 3 months, and heavy labor after 6 months.⁶

Dynamic Scapholunate Instability

A dynamic scapholunate instability is characterized by a complete SL ligament tear, but the secondary scaphoid stabilizers—the scaphotrapezium (ST), scaphocapitate (SC) and radioscapocapitate (RSC) ligaments—are still preserved.⁸

Table 1 Arthroscopic classification of SL lesions according to Messina

STAGE	Arthroscopic findings
I	
II, SLIL proximal part lesion	Lesion of central/proximal part of SLIL
III A, SLIL partial anterior lesion	Lesion of anterior, proximal part of SLIL, lesion of SC/LRL
III B, SLIL partial posterior lesion	Lesion of proximal and posterior part of SLIL, lesion of DIC
III C, SLIL complete lesion reducible	Complete lesion of SLIL (anterior, proximal, posterior), lesion of an extrinsic ligament (DIC or SC/LRL)
IV, SLIL complete lesion with gap	Complete lesion of SLIL (anterior, proximal, posterior) + extrinsic ligaments lesion (DIC, SC/LRL)

The scapholunate instability or gapping can be seen radiographically only under certain loading conditions or in specific wrist positions such as the clenched-fist position, or loading the wrist in ulnar deviation. A direct scapholunate ligament repair is indicated when (1) the dorsal SL ligament is reparable, (2) the scapholunate joint is reducible, and (3) there is no articular cartilage damage (traumatic or degenerative).⁹

Surgical Technique

Various authors advise a dorsal approach to the wrist capsule between the third and fourth extensor compartment.^{10,11} Berger and Bishop¹² have described a ligament-sparing dorsal capsulotomy. The first incision is made along the dorsal rim of the radius to the center of the lunate fossa. The second incision is made from the end of the first incision following the fibers of the dorsal radiocarpal ligament to its distal insertion onto the dorsal ridge of the triquetrum. The third incision is made from the scaphotrapezotrapezoid (STT) joint progressing medially along the dorsal intercarpal ligament to its insertion onto the dorsum of the triquetrum. By connecting the last two incisions, a radially based capsular flap is created. This flap is carefully elevated by sectioning its connections to the dorsal edge of the three bones of the proximal row. I have recently been using a transversal cutaneous mini-

access approach that permits the surgeon to reach the dorsal wrist capsule without sectioning the extensor retinaculum (►Fig. 2a–e).

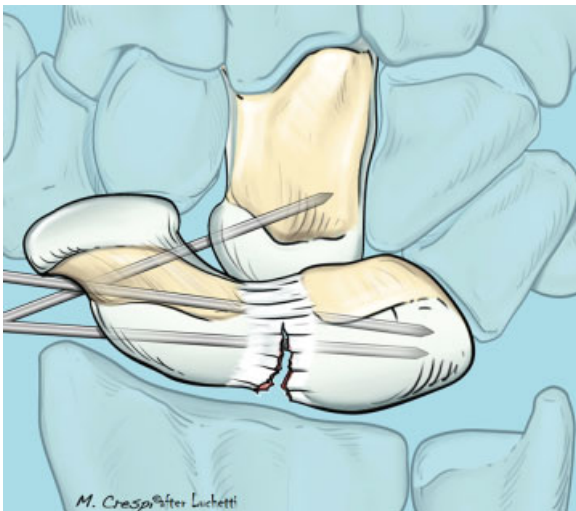
If the ligament is avulsed (often with a little osteochondral fragment), then the repair consists of reinserting the avulsed ligament into the scaphoid crest or onto the lunate with a 2.4- or 2.8-mm suture anchor (►Fig. 3),^{9,13} combined with SL and/or SC pinning as described by Linscheid¹⁴ and Lavernia et al.¹⁵ When an osseous fragment is attached to the ligament, it can be reattached to its original position or excised if too small. In many cases this technique is augmented with a capsular or dorsal intercarpal ligament (DICL) dorsal capsulodesis.^{16–18} The K-wires are maintained in place for 6–8 weeks, followed by the application of a removable splint for another 4 weeks and protected wrist motion.

Outcomes

Pomerance reviewed 17 patients following a scapholunate interosseous ligament (SLIL) repair and dorsal capsulodesis at an average follow-up of 66 months (range, 19–120 months).¹⁹ The SL gap for a strenuous job was 4 mm static and 6 mm with stress, while for a nonstrenuous job the SL gap was 2 mm static and 3 mm with stress. The mean Disabilities of the Arm, Shoulder, and Hand (DASH) score for a strenuous job was 37 (range, 22–44), and for a nonstrenuous job, 25 (range, 19–35). The Modified Mayo wrist score included 2 good, 10 fair, and 5 poor results. Pomerance noted that, overall, the results of repair degrade over time.

Dorsal Capsulodesis. The dorsal capsulodesis that was popularized by Blatt^{16,20} as an isolated procedure for scapholunate instability is no longer in vogue. A variety of techniques using all of or part of the DICL to reinforce the dorsal SL ligament have been described (►Fig. 4). One of these techniques is to use a portion of the DICL, leaving its insertion into the triquetrum (►Fig. 5) and rotating its radial portion to insert into the dorsoulnar corner of the scaphoid. Berger has proposed another technique²¹ that isolates a portion of the DICL flap at the base of the scaphoid and rotates and fixes it with suture anchors to the lunate (►Fig. 6a–f).

We reviewed 18 patients with chronic predynamic or dynamic scapholunate instability who were treated by a dorsal intercarpal ligament capsulodesis.¹⁷ At an average follow-up of 45 months, a significant decrease in pain ($P > 0.05$) with improvement in grip strength ($P > 0.005$)

**Fig. 1** Technique of SL joint pinning with K-wires.

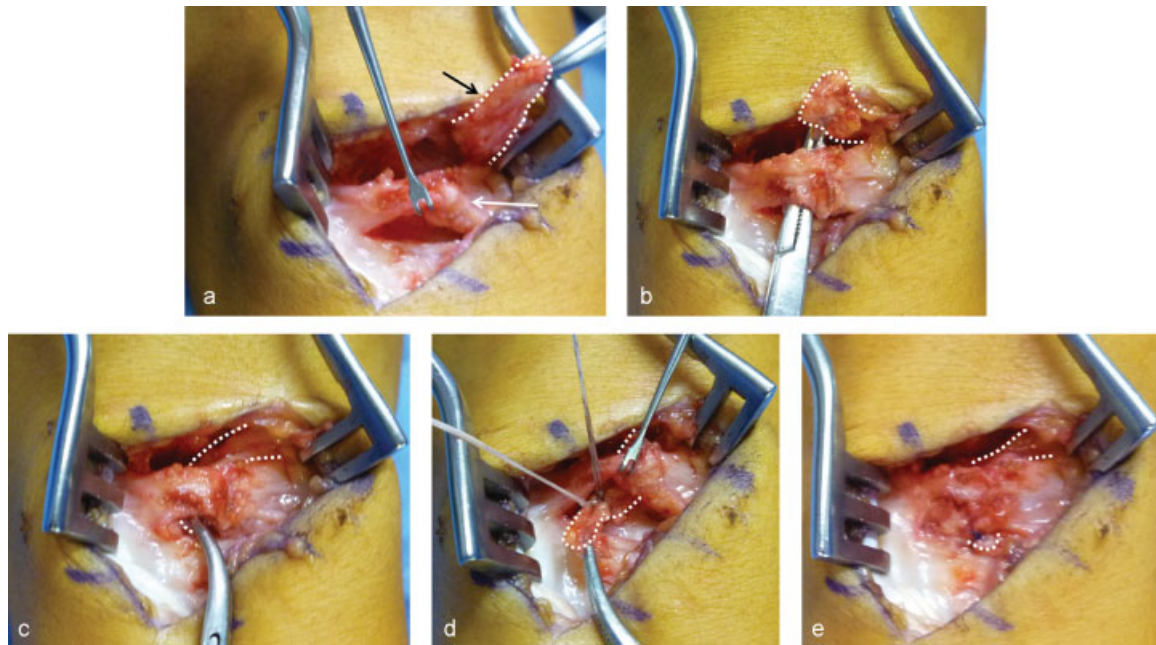


Fig. 2a–e Surgical technique of dorsal capsulodesis by using a short skin incision with extensor retinaculum preservation. (a) Capsule exposure with maximum preservation of the capsule itself (white arrow) using a double almost-parallel capsular incision. The proximal incision is on the dorsal radius, and the second one is on the midcarpal joint following the direction of the dorsal intercarpal ligament (DICL) fibers. After synovectomy, a DICL flap fixed at the scaphoid is elevated (white dotted line). (c) A tunnel space is created under the capsule over the SL ligament level and a curved mosquito is passed to keep the DICL flap. (c) The DICL flap is passed under the capsule through the tunnel and (d) is fixed to the dorsal border of the lunate with a suture anchor. (e) Capsule is sutured at the end.

was observed in all cases (→**Fig. 7a–f**). Moran et al²¹ reviewed 18 with dynamic carpal instability and 13 with static carpal who underwent a dorsal capsulodesis. The average time from injury to surgery was 20 months. The follow-up period averaged 54 months (range, 24–96 months). All patients had a dorsal capsulodesis procedure using either a Blatt or a Mayo technique. There was a 20% decrease in wrist motion after capsulodesis. There was no improvement in grip strength after surgery. Most patients had improvement in

pain, but only two patients were completely pain-free. Radiographically the SL gap increased over time from 2.7 mm before surgery to 3.9 mm at the final follow-up evaluation. The SL angle also increased from 56° before surgery to 62° on final follow-up evaluation. There was no statistical difference in overall wrist motion, grip strength, or wrist score between the dynamic and static groups. The time to surgery and age had no significant effect on overall outcome. Although pain was improved, it was not completely resolved in the majority

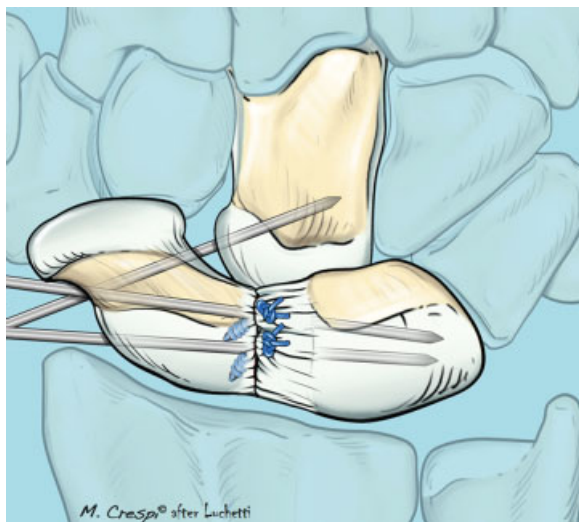


Fig. 3 SL ligament repair with two suture anchors and pinning.

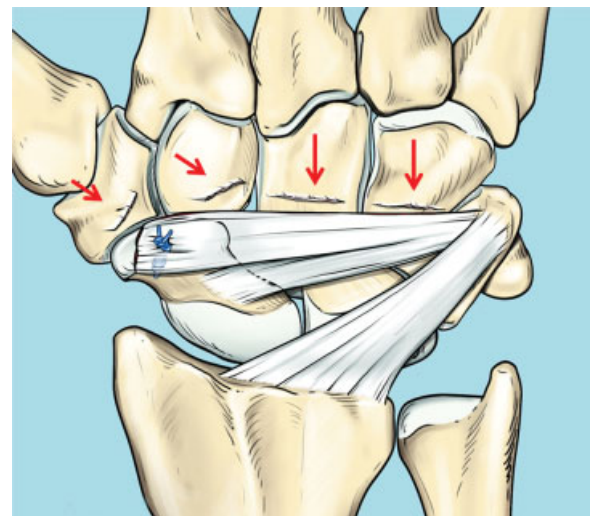


Fig. 4 Technique of SL dorsal capsulodesis proposed by Szabo using the entire DICL.

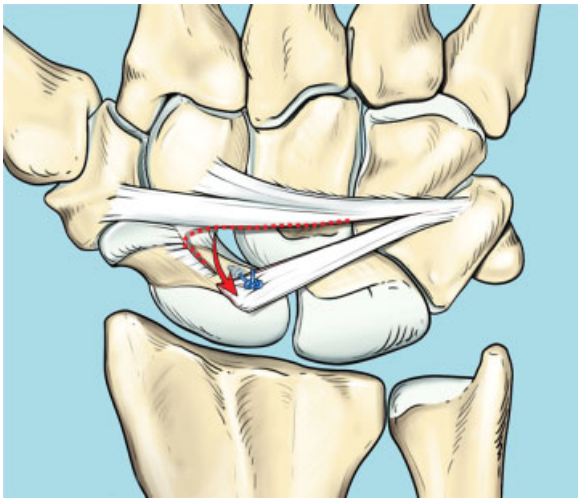


Fig. 5 Technique of SL dorsal capsulodesis using part of the DCLL detached from the distal scaphoid and transferred to its proximal part across the SL ligament.

of cases. From a radiographic perspective, dorsal capsulodesis did not provide maintenance of carpal alignment in cases of chronic SL dissociation.

Gajendran et al reviewed 15 patients (16 wrists) with chronic SL instability who were treated with a DCLL capsulodesis.²² At an average follow-up of 86 months (range, 70–115 months) the average wrist flexion was 50° (± 12) and extension 55° (± 15). The average SL gap was 2.7 mm at 25 months and 3.5 mm at 86 months. The average DASH score was 19 (range, 0–66). A modified Mayo score included 6 excellent, 3 good, 5 fair, and 2 poor results. 8 of the 16 wrists developed osteoarthritis (OA).

Bone–Ligament–Bone Transplant. The bone–ligament–bone (BLB) graft has been proven to be quite successful in knee ligament surgery, and various authors have studied this technique biomechanically to see whether it can be used to

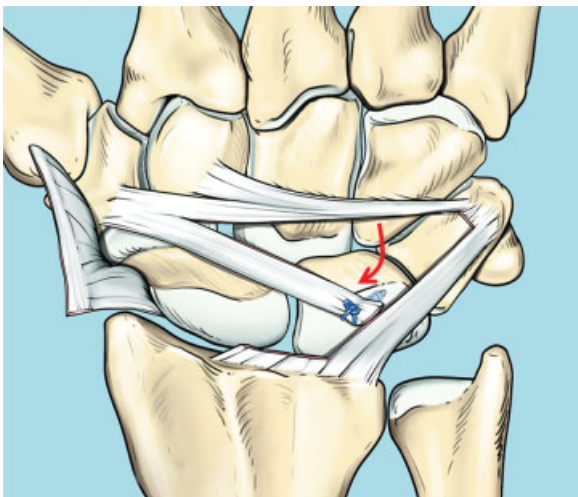


Fig. 6 Technique of SL dorsal capsulodesis using part of the DCLL detached from the triquetrum and transferred to the lunate across the SL ligament (Berger technique).

substitute for a nonreparable SL ligament.^{23–29} Schuind³⁰ recommended use of a vascularized flap of the interosseous membrane. Weiss³¹ described the transfer of a BLB graft harvested from the Lister tubercle. This can be supplemented with a dorsal capsulodesis. Harvey and Hanel²⁷ suggested harvesting a BLB from the third metacarpal and the capitate. The surgical approach is the same in cases of direct ligament repair. Once the carpal bones are reduced and stabilized with K-wires, a fossa is created on both bones where the bony portions of the BLB complex will be placed. These can be stabilized with mini-screws or suture anchors that have previously been inserted (► **Fig. 8**).

Possible potential problems include poor integration of the graft (because the proximal pole of the scaphoid has a tenuous blood supply) as well as deterioration of the mechanical properties of the graft with prolonged immobilization. The preliminary clinical results of Schuind,³⁰ Weiss,³¹ Harvey,²⁷ and Atzei²⁵ are encouraging in cases where the secondary stabilizers are still functional (dynamic instability).

Our personal experience²⁵ showed excellent results in six of the nine cases at a mean follow-up of 7 years with an average modified Mayo wrist score of using a BLB graft taken from the third metacarpal and the capitate. Wrist motion remained unchanged in eight patients and the pain decreased by an average of 1.7 on Visual Analogue Scale (VAS). Eight patients returned to their previous jobs and recreational activities (► **Fig. 9a–k**). However, there was a poor correlation between the clinical and radiological results: the Glickel score averaged 10.5, and there were 5 good, 2 satisfying, and 2 poor results. Only one case failed (► **Table 2**).

Static Reducible Scapholunate Dissociation

An SL dissociation is considered to be “static reducible” when (1) the ligament tear is degenerative and irreparable; (2) the secondary stabilizers (i.e., the STT and SC ligaments^{3,8}) are insufficient, which results in a static dorsal intercalated segment instability (DISI) malalignment; (3) the carpal subluxation is still reducible; (4) there is no degeneration of the articular surfaces. These patients can be treated with a tendon graft reconstruction of the SL ligament^{3,32,33} and/or a Reduction–Association of the SL articulation (RASL) procedure.^{14,15,34}

Tendon Reconstruction. The use of tendon grafts for reconstructing the SL ligament has evolved considerably from the time of its initial description by Dobyns et al³⁵ in 1975. Brunelli and Brunelli described a tenodesis using a strip of the FCR tendon with encouraging results.³² Most of their patients were able to return to their prior occupations with complete remission of pain and recovery of grip strength, but with an average loss of 45° of wrist flexion in comparison to the contralateral side.³⁶ For this reason the method was modified by Van Den Abbeele et al.³⁷ by anchoring the graft to the lunate rather than to the distal radius (► **Fig. 10**).

Outcomes

Moran et al examined 29 patients with isolated chronic SL instability.²¹ Fourteen had a dorsal capsulodesis, and 15 had

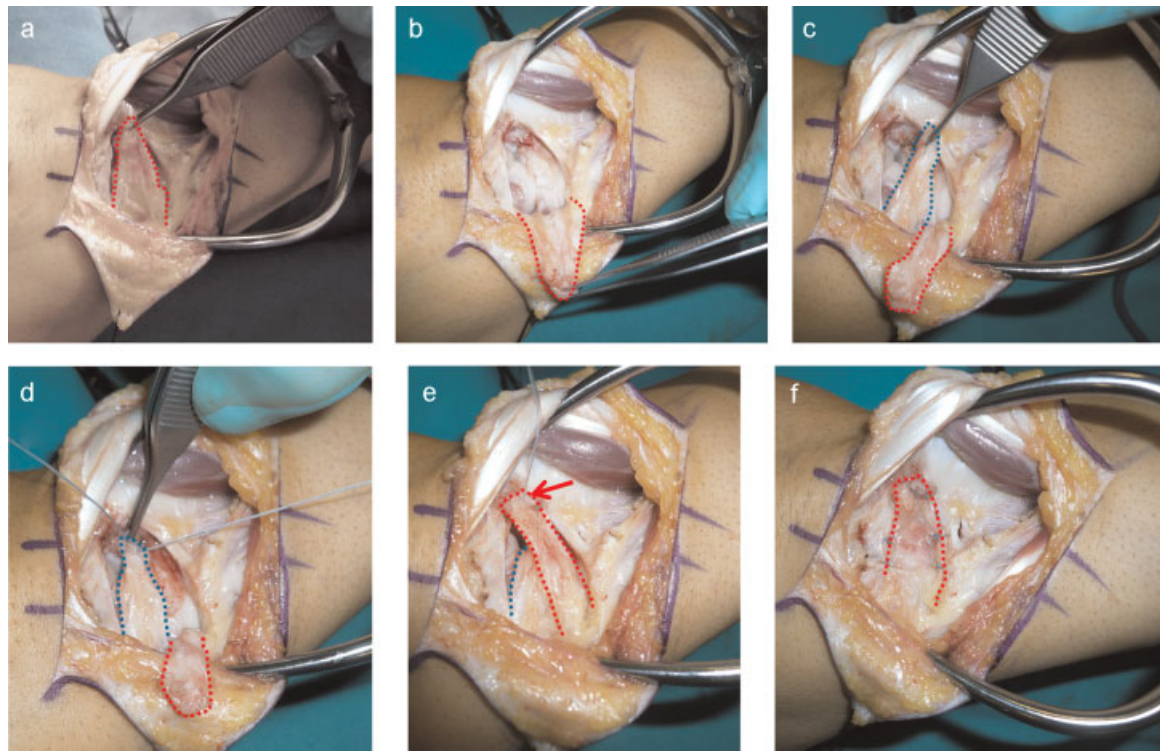


Fig. 7a-f Surgical demonstration of the SL dorsal capsulodesis using the Berger technique. (a) Dorsal radio-carpal capsular incision (red dotted line) according to Berger and Bishop (ligament splitting capsulotomy)¹²; (b) Rotation of the radiocarpal capsule flap (red dotted line), exposing the carpal bones. (c) DCL flap dissection (blue dotted line) from the radiocarpal-capsule flap (red dotted line). (d) Suture of the DCL flap (dorsal capsulodesis) to the lunate with a suture anchor. (e) Coverage of capsulodesis (blue dotted line) with the remnant radiocarpal capsule (red dotted line), in which particular attention is paid to suturing it at the ulnar border (red arrow). (f) Complete suture of the radiocarpal dorsal capsule (red dotted line).

undergone a modified Brunelli procedure similar to the three-ligament tenodesis described subsequently. At an average follow-up of 36 months (range, 24–84) the capsulodesis group showed an average wrist flexion of 44° (range, 10–55), average extension of 49° (range, 15–70) with an average SL gap of 4.5 mm,²⁻⁶ whereas the tenodesis group showed an average wrist flexion 40° (range, 10–60), and extension of 43°

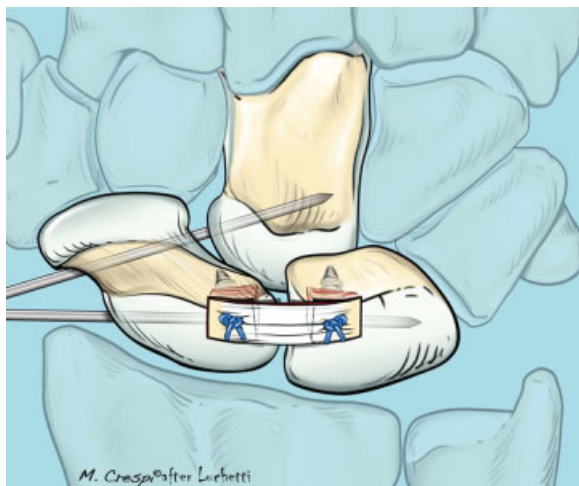


Fig. 8 Drawing showing the bone–ligament–bone complex transferred and fixed to the lunate and the scaphoid with suture anchors in association with SL and SC pinning.

(range, 20–65) and an average SL gap of 4.3 mm.²⁻⁸ The modified Mayo wrist score for the capsulodesis group revealed one excellent, five good, six fair, and one poor result as compared with the tenodesis group, which had three excellent, three good, six fair, and three poor results. Chabas et al reviewed 19 patients with chronic SL instability were treated with a modified Brunelli tenodesis at an average follow-up of 37 months (range, 12–60).³⁸ Fifteen patients had no to mild pain, four had constant pain. The average wrist flexion was 41° (range, 10–60), and extension 50° (range, 20–65). The average static SL gap was 3.2 mm. The average DASH score was 30 (range, 0–91). The Wrightington score was as follows: nine excellent, six good, three fair, and one poor result. One patient developed SLAC stage II arthritis.

Three-Ligament Tenodesis. Garcia et al^{3,33} further modified the Brunelli technique and described a three-ligament tenodesis (3LT) (► Fig. 11).

Surgical Technique

A dorsal ligament-sparing capsulotomy is performed. An oblique tunnel along the longitudinal axis of the scaphoid is created, from dorsal to palmar, entering at the level of the original insertion site of the dorsal SL ligament, and aiming at the palmar tuberosity. A strip of the FCR tendon is then obtained. At the level of the distal pole of the scaphoid, a small, transverse palmar incision is made, and the distal part of the FCR is identified. The tendon is split. The skin is incised

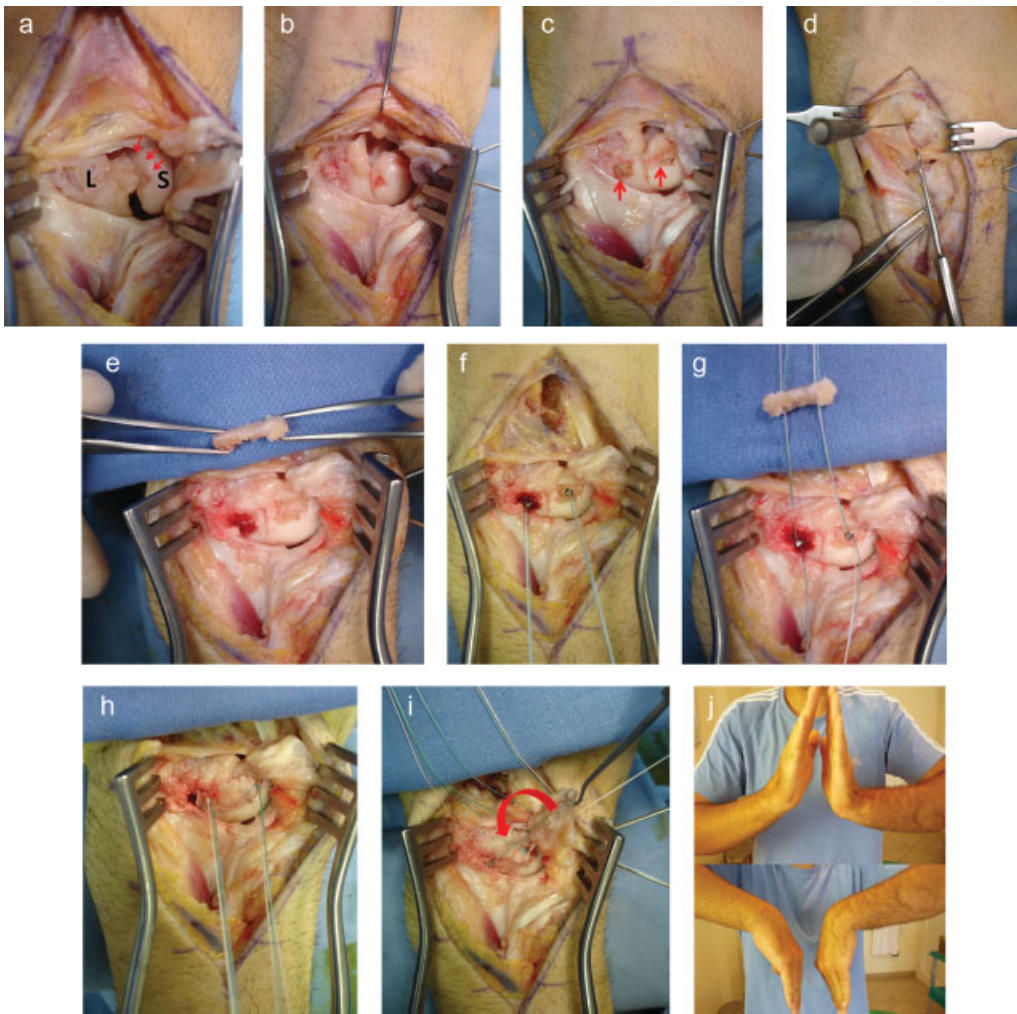


Fig. 9a–k Surgical procedure of SL ligament reconstruction with BLB technique. (a) Through a splitting capsulotomy the SL joint (S: scaphoid; L: lunate) is exposed and the SL ligament is completely detached from the lunate (red arrows). (b) Two K-wires are used to temporarily fix the SL and SC bones. (c) Red arrows show the two small fossae created on both scaphoid and lunate bones where the bony portions of the BLB complex will be placed. (d) Third carpometacarpal (CMC) space is localized by a needle. (e) BLB is prepared ready to be transferred to the SL bones. (f) Two suture anchors are positioned into the scaphoid and lunate fossae ready to receive the BLB. (g) Sutures are passed through bone holes previously prepared in each part of the BLB. (h) BLB sutured in situ. (i) Dorsal capsular flap is turned (red arrow) to cover the carpus and some stitches are passed through the capsule to fix it to the BLB. (k) Wrist motility at 3 months of follow-up.

at the musculotendinous junction, and a radial strip of the FCR is released at the musculotendinous junction and left attached distally. The FCR tendon strip is passed through the oblique scaphoid tunnel using a wire loop or a tendon passer. A transverse trough or channel is then made over the dorsum of the lunate with a rongeur. A small anchor suture is placed into the floor of the trough. A slit is made in the distal end of the dorsal radiotriquetral (RT) ligament, and the tendon strip is passed through the slit from volar to dorsal. The ligament is used as a pulley to tension the strip. The scaphoid, lunate, and capitate are reduced and stabilized with two 1.5-mm K-wires prior to tensioning the tendon graft. One wire is placed across the SL joint and one across the scaphocapitate joint. The tendon graft is secured tightly down into the cancellous bone channel created in the lunate using the suture anchor. The end of the tendon strip is then sutured to itself and the capsule is closed.

Garcia-Elias et al reviewed 38 patients with a symptomatic SL dissociation who had undergone a 3LT procedure.³³ At a mean follow-up of 46 months (range, 7–98 months), pain relief at rest was obtained in 28 patients, with 8 complaining of mild discomfort during strenuous activity and 2 having frequent pain. Twenty-nine resumed their normal occupational-vocational activities. The average ranges of motion at follow-up evaluation were 51° of flexion (74% of contralateral side), 52° of extension (77% of the contralateral side), 15° of radial inclination (78% of the contralateral side), and 28° of ulnar inclination (92% of the contralateral side). There were no signs of scaphoid necrosis. Recurrence of the carpal collapse occurred in two wrists.

Our experience on 15 cases demonstrates a net reduction in pain under force measured on a VAS of 8 (preoperative) and 1 (postoperative), an increase in grip strength of 26 to 33 kg, and a reduction of wrist flexion and extension by ~10%. All

Table 2 Radiologic grading system according to Glickel

SCAPHO-LUNATE GAP: < 2 mm (2)	DISI/VISI: absent (2)
> 2 mm (0)	borderline (1)
	present (0)
RING SIGN: absent (2)	
present (0)	OSTEOARTHRITIS: absent (3)
	1 + (2)
SCAPHOID FLEXION: absent (2)	2 + (1)
present (0)	3 + (0)
G-L ANGLE: 0–10° (2)	
10–20° (1)	FINAL RESULT: excellent 14–15
20° (0)	good 11–14
	sufficient 7–11
SCAPHO-LUNATE ANGLE: < 70° (DISI). (2)	poor 3–7
70–80° (DISI). (1)	bad 0–3
>80° (DISI). (0)	

Glickel SZ, Millender LH: Ligamentous reconstruction for chronic intercarpal instability. *J Hand Surg* 1984, 9A, 514–527.

the patients returned to their sport and prior activities of daily living. The average DASH score was 27 (59 preoperative), and the average patient-rated wrist evaluation (PRWE) score was 18 (39 preoperative). The post-operative X-ray images always demonstrated a persistent SL gap, with an increased wound SL angle even though the Watson test was negative (→Fig. 12a-g).

Bain³⁹ modified this technique to reinforce the DICL, which is a secondary wrist stabilizer, thus obtaining a quad-ligament tenodesis. The FCR tendon strip is advanced through the scaphoid and stabilizes the volar scaphotrapezium ligament, dorsal SL ligament, RT ligament, and DICL (→Fig. 13). The dorsal approach is closed using an ulnar advancement V-Y

capsulodesis with the dorsal capsule further reinforcing the DIC and DRC ligament.

A more simple alternative to these procedures is a dorsal dynamic tenodesis using the extensor carpi radialis brevis (ECRB) as described by Brunelli⁴⁰ (→Fig. 14). It does not directly reconstruct the SL ligament but rather limits scaphoid flexion by attaching the ECRB tendon into the distal dorsal part of the scaphoid, similar to a Blatt capsulodesis.

RASL technique. Herbert et al⁴¹ described a new approach based on their observation that a failed SL arthrodesis often leads to superior results than those obtained with a fusion. This innovative technique consists of an open reduction, repair of the residual ligament, and protection of the repair

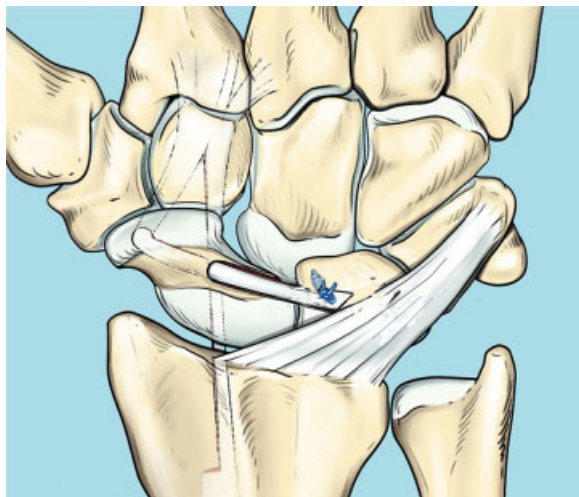


Fig. 10 Technique of surgical reconstruction of the SL ligament by using the FCR tendon strip according to Van Den Abbeele et al. The tendon is fixed to the lunate.

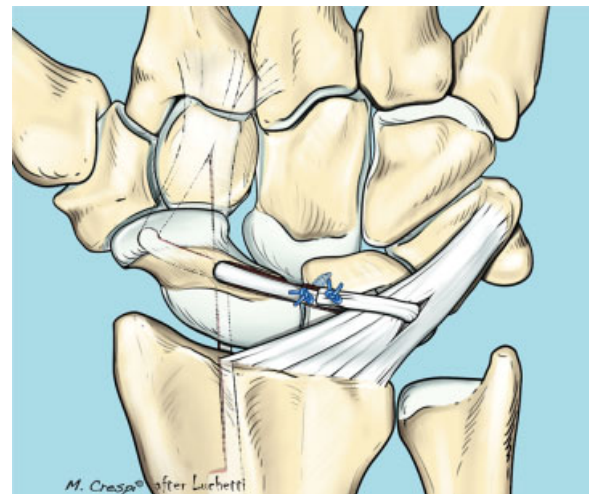


Fig. 11 Technique of surgical reconstruction of the SL ligament by using the FRC tendon strip according to Garcia-Elias.

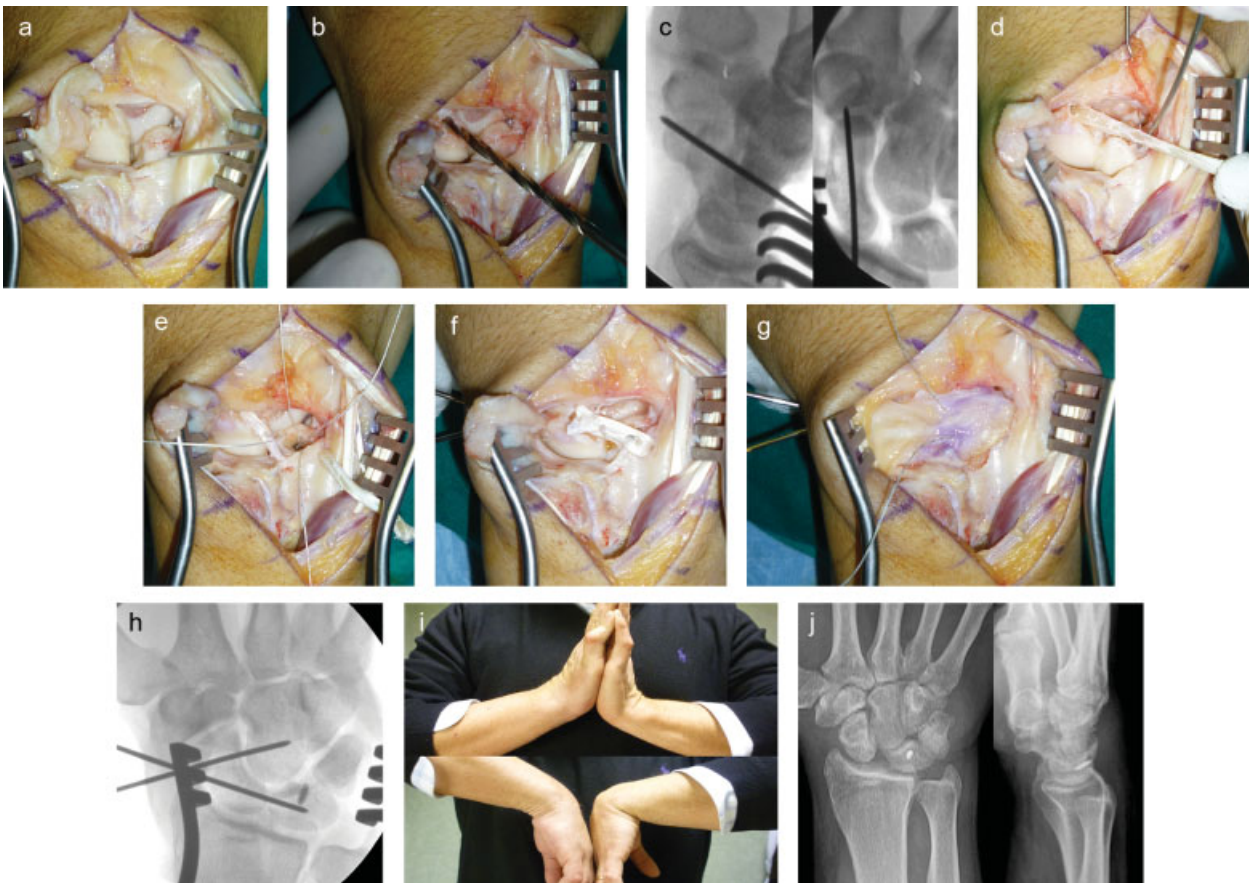


Fig. 12 Surgical procedure of SL ligament reconstruction with FCR tendon strip according to Garcia-Elias. (a) Through a splitting capsulotomy the SL joint is exposed and the SL ligament is absent. (b) Scaphoid bone tunnel is prepared using a drill starting from the proximal dorsal side of it. (c) X-ray images show the position of the K-wires in lateral and AP views. (d) FCR tendon strip is passed through the tunnel from the palmar to the dorsal side. (e) The tendon strip is prepositioned into the RT ligament, a limited fossa is created in the position of the previously existing SL ligament to the dorsal side of the lunare, and a suture anchor is positioned. (f) The tendon strip is pulled and sutured at the lunare fossa and to itself by separated sutures. SC and SL joints are temporary fixed by two K-wires. (g) Splitting capsule is turned to cover the joint, and suture is used to fix it to the tendon strip. (h) Intraoperative fluoroscopy showing the correct position of both the K-wires and the suture anchor with anatomical closure of the SL joint. (i) Clinical result at follow-up: good flexion-extension of the wrist. (j) X-ray images at the follow-up that show the recurrence of SL limited dissociation (completely asymptomatic).

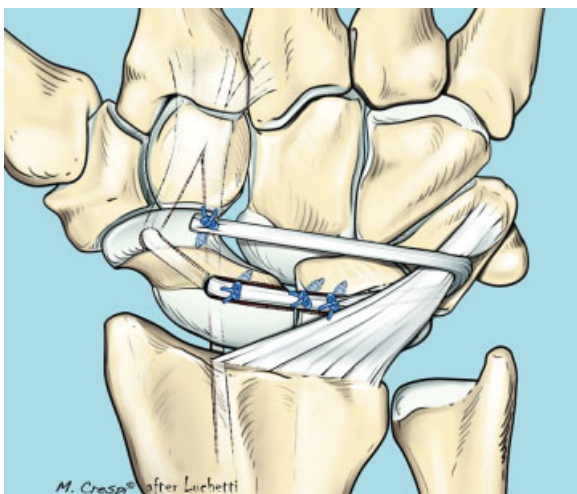


Fig. 13 Technique of quad tendon reconstruction of SL ligament according to Bain.

by blocking the SL articulation with Herbert screws for 12 months or more. The scope of this technique is to obtain an intercarpal fibrosis that is sufficient to permit full loading of these two bones while using the screw to control the scapholunate diastases (► **Fig. 15a,b**). Rosenwasser et al popularized the reduction and association of the scaphoid and lunate (RASL) procedure using a cannulated Herbert screw.⁴² He recently reported excellent long-term results in 31 patients with a chronic static SL instability at an average follow-up of 6.4 years (range: 16 months–18.0 years).⁴³ The mean DASH score was 17.0 (range: 0 to 50.8), and the mean VAS was 1.65 (range 0–7.3) with moderate activity.

Using a screw to stabilize the scapholunate interval, however, is not as successful. Filan and Herbert⁴⁴ wound and Fernandez⁴⁵ recommend removing the screws after a few months on account of the technical difficulty and long-term disastrous effects of leaving the screw in place. Cagnet et al⁴⁶ published poor results and focused their attention on the

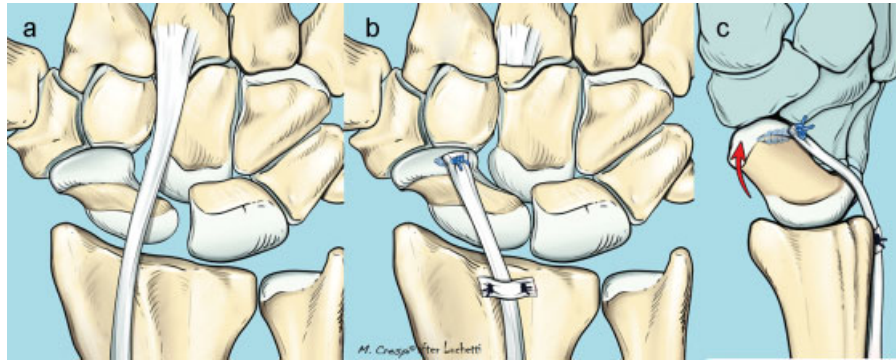


Fig. 14 Technique of dynamic tenodesis using the ECRB tendon transferred to the distal part of the scaphoid.



Fig. 15a,b X-ray images of RASL technique (a and b).

disastrous consequences due to the retained a the screws: in all their cases, the lunate and proximal part of the scaphoid were destroyed with severe secondary degeneration of the radio-carpal articulation. They concluded that this technique should never be used.

Garcia-Elias³ has proposed a treatment algorithm that can be referred to each time we are faced with treating a patient affected by an SL ligament lesion (► **Table 2**).

Note

Work was done at the Rimini Hand Surgery and Rehabilitation Center.

Conflict of interest

None

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